Look in the jar and you will see a slender ribbon of light extending downward through the jar. Elsewhere it is quite dark and black. Here we see the light streaming through the opening in the card, and lighting up the particles of smoke in its path.

Take off the card, and let the reflected beam fall freely into the jar. The smoke is now wholly illuminated, and the jar appears to be full of light, and every part of the bottle shines with a pale-white glow.

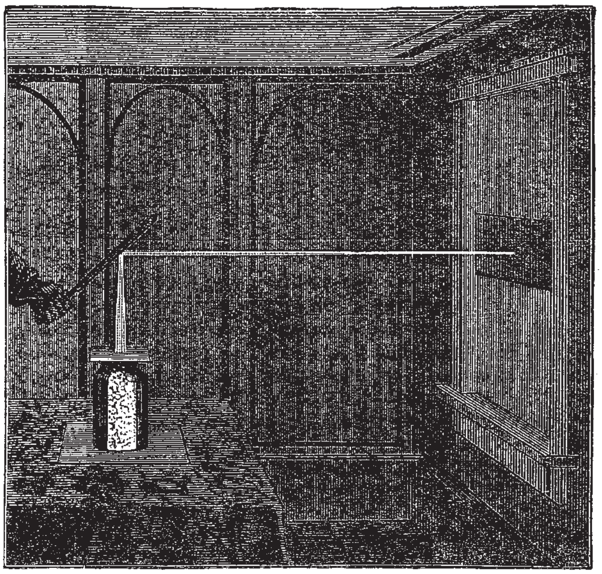

FIG. 6.

Put the postal-card on again and let the light fall through the slit. The smoke has nearly all disappeared, and the ribbon of light in the jar is quite dim. Curious streaks and patches of inky blackness run through it. What is this? Nothing—simply nothing. The smoke is melting away, and the beam of light disappears because there is nothing to reflect it and make it visible.

This part of the experiment appears quite magical in its effects, and is exceedingly interesting.

The Milk-and-Water Lamp

Take away the jar and put a clear glass tumbler in its place. Fill this with water and throw the beam of reflected light down upon it, and the water will be lighted up so that we can easily see the tumbler in the dark. Now add a teaspoonful of milk to the water and stir them together. Throw the beam of light down once more. This is indeed remarkable. The tumbler of milk-and-water shines like a lamp, and lights up the room so that we can easily see to read by its strange white light. Move the mirror and turn aside the beam of light, and instantly the room becomes dark. Turn the light back again, and once more the glass is full of light.

Here the minute particles of milk floating in the water catch and reflect the light in every direction, so that the entire goblet seems filled with it, and the room is lighted up by the strange reflections that shine through the glass.

AMERICAN GEOLOGICAL SURVEYS

MISSOURI

THE State of Missouri boasts of abundant mineral wealth. Its seams of coal and its stores of iron and lead mark it out as one of the great centres of the future industry of the United States. Such a country might have been supposed only too anxious to have its mineral formations accurately mapped, so as to know exactly where and how its subterranean resources lie. Yet the history of its official action in this matter is by no means a gratifying one. As far back as the year 1849 a memorial was presented to the General Assembly of the State, praying for the formation of a Geological Survey, with liberal appropriations for constructing maps and publishing reports; for investigating causes affecting health, the agricultural capacities of different soils, the water system, and the rocks and minerals of the country. It was not until the early summer of 1852 that the State geologist, who, in response to this memorial, was appointed, began operations. Five annual reports, consisting for the most part of only a few leaves, appeared up to the year 1861, and, with one exception, contained mere statements of progress. Perhaps the Legislature began to think that the results obtained were not worth the expenditure to secure them. At all events, in 1861 the Survey was disbanded. The authorities, however, seem to have been unwilling that the fruits of the long years of work of their geological staff should be lost; they accordingly arranged to have them published, but finally abandoned this idea on account of the expense. For nine years nothing further appears to have been done in the matter. At last, in 1870, the Legislature once more roused itself to consider the expediency of having the country properly explored and mapped. A "Mining, Metallurgical, and Geological Bureau" was now created, and a new State geologist was appointed. This arrangement, however, not proving satisfactory, the act was amended next year, but soon thereafter the State geologist resigned, and Mr. R. Pumpelly took his place. The body by which the geological work of the State was controlled, now called the "Bureau of Geology and Mines," consisted of a board of five managers, with a staff formed of a State geologist, an assistant palæontologist and geologist, an assistant chemist, and such additional assistance as might be possible within the limits of an annual appropriation of 10,000 dollars.

By the spring of 1872 a more liberal spirit had appeared in the assembly. An additional chemical assistant was allowed, and the annual vote was raised to 20,000 dollars. The Survey now set to work with prodigious vigour. Mr. Pumpelly and his associates undertook an extensive exploration of the iron and coal districts, while the chemists were busy analysing the minerals sent into them from the field. By the end of the year a large mass of information had been collected, and as the liberality of the Legislature had shown no sign of waning, a large appropriation was asked for the publication of the results obtained in 1872, and another grant for the issue of the still unprinted reports of previous years. Both these appropriations, amounting to 9,000 dollars in the one case, and 3,000 dollars in the second, were voted. Accordingly two volumes duly appeared next year. The Report for 1872 was sumptuously printed and illustrated. Moreover, it was accompanied by a monstrous atlas of chromo-lithograph maps and sections. Some parts of the coal-fields were carefully illustrated by sections to show the structure of the areas and the relative positions of the seams in different districts. Perhaps some of these sections were on a needlessly large scale. Certainly the whole atlas was issued in a style so luxurious as to suggest that the Legislature must not only have become more liberal, but must be anxious to atone for former delinquencies by an almost extravagant expenditure in print and paper.

But this golden age was not destined to last. Mr. Pumpelly resigned, very shortly after the appearance of his meritorious though costly volumes. His successor, Mr. G. C. Broadhead, who had previously acted as chief assistant-geologist, found the fund at his disposal so depleted by the heavy expenses of the winter and spring of 1873, that he had to reduce his field-staff. The Board of

Management likewise determined that the cost of the Annual Reports should in future be paid out of the yearly appropriation, thereby of course, considerably narrowing the possible amount of work to be done in the field. In spite of these drawbacks, however, the State-geologist succeeded, during his first year of office, in doing some useful work, and yet kept a sufficient balance to publish a bulky report with a quarto atlas of plates. His plan was to attack first of all those branches of inquiry which presented the greatest interest or had the closest bearing upon the industrial resources of the State. The ground was surveyed by counties, Mr. Broadhead himself taking a lion's share of the hard work. The two lead regions of Southwest and Central Missouri were likewise examined. Many analyses were also made of the ores, slags, coals, and other mineral substances sent up to the office. The Report which gave an account of these labours cannot fail to be of great service in the development of the mineral resources of the State. Mr. Broadhead is evidently exactly the kind of director needed to keep the Missouri Geological Survey in full activity and to satisfy the demands of a utilitarian legislature.

The oldest rocks in Missouri appear to be certain granites and other crystalline masses, on which lie somewhere about 3,000 feet of Lower Silurian strata, including representatives of the Potsdam, Black River, Birdseye, Trenton, and Cincinnati groups of other parts of the United States. Upper Silurian rocks are much more feebly represented, but Dr. Shumard has recognised beds probably equivalent to the lower Helderberg and Niagara groups. The Devonian groups of Hamilton and Onondago are still more sparingly developed, only about 100 feet of strata being referable to those horizons. The Carboniferous system, however, is well displayed, and contains the following groups :—

Lower.	Upper coal-measures (poor in coal)	1,307	feet.
	Middle ,, (with 7 ft. of coal)	324	,,
	Lower ,, (with 13 ft. 6 in. of coal) ...	250–300	,,
Upper.	Chester group (sandstone) from a few feet to ...	100	,,
	St. Louis ,, (limestone), maximum	250	,,
	Keokuk ,, (shale and chert), perhaps exceeding	200	,,
	Encrinital or Burlington group	60	,,
	Chouteau limestone	100	,,
	Vermicular sandstone and shales	75	,,
	Lithographic limestone	55	,,

No later formations occur until we reach the "Drift. This consists of two divisions ; the lower, formed of dark blue clay, overlaid and interstratified with beds and pockets of sand sometimes inclosing remains of terrestrial vegetation ; the upper composed of stiff, tenacious, brown, drab, and blue clays, often mottled, and containing rounded granitic pebbles. Large boulders of crystalline rocks from a northern source occur in the lower division, up even to a height of 1,050 feet above the level of the Gulf of Mexico. Most of the observed boulders occur in the valleys. They diminish in numbers and size as they are traced southwards, the Missouri River seeming to limit their extension in that direction. Above these clays lies the "bluff," or loess, a very fine light brown siliceous marl, with occasional concretions of limestone. With sufficient consistency to weather out into perpendicular escarpments, this deposit forms a belt of hilly country receding ten miles from the river, and then changing into a stiff clay which may be part of the "drift." The low alluvial lands lie on what is termed the "bottom prairie," generally a dark tenacious clay, often containing concretions of bog-iron, and rarely beds of sand.

From the early part of last century lead and iron have been worked in Missouri. The mining industry of the State has gradually developed, and is now making rapid progress. In the year 1872, 13,550,135 pounds of lead were produced in the State. During the first six months of 1874, 5,050 tons of pig-lead were sent by railway into St. Louis. The yield of iron and zinc is likewise steadily increasing. Vast quantities of sulphate of baryta are said to be raised, and to be used in the improvement (that is, the adulteration) of white lead. A territory so richly stored with mineral wealth ought to be able to equip and maintain a sufficient staff for the thorough exploration of the geological and mineralogical structure of the ground, and for the formation of a museum where the rocks, minerals, fossils, and manufactured mineral products may be displayed, and made practically useful and instructive.

ARCH. GEIKIE

OUR ASTRONOMICAL COLUMN

DUN ECHT OBSERVATORY PUBLICATIONS, VOL. II.—In this handsomely-printed volume of two hundred pages we have the first portion of results of observations made during Lord Lindsay's expedition to the Mauritius on the occasion of the late transit of Venus, an expedition which for the care and forethought bestowed upon the arrangements and the excellence and completeness of the equipment, compares favourably with any of those fitted out by the various Governments which took part in the observation of this rare phenomenon.

It was upon the strong recommendation of the eminent Secretary of the German Transit of Venus Commission, Prof. Auwers, that Lord Lindsay was induced to take out a heliometer, and an instrument of this class, similar to those intended to be used in the Russian expeditions, was ordered in the spring of 1872 and completed in due time by the joint exertions of Messrs. Repsold, of Hamburg, and Messrs. Cooke and Sons of York. In the investigation of the constants of the instrument previous to the expedition, experience was obtained of the great precision to be attained in the measurement of angular distance between two stars by its means, and this experience led to a determination to take advantage of a near opposition of the minor planet Juno, occurring during the anticipated period of residence at the Mauritius, to investigate the solar parallax, from the diurnal parallax of the planet, by measuring its distance and angle of position with respect to a star, both morning and evening. On November 4 Juno in perigee was distant 1·029, and though the parallactic displacement in such case is considerably less than in a transit of Venus, or an opposition of Mars, it was believed that the great accuracy attained in measures with the heliometer would more than compensate for this disadvantage.

Vol. ii. of the publications of Lord Lindsay's Observatory is devoted to the discussion of the observations of Juno, preceded by a very detailed account of the instrument and its adjustments and of the methods adopted in determining its instrumental errors, as errors of scale divisions and errors of screw and of the method of observation and calculation of instrumental results. And in the event of criticism of any of the processes it must be stated that the whole of the work is so presented as to admit of future discussion, with any modification of plan that may be deemed advisable. It was originally intended that the observations should commence on October 10 and continue to the end of November. Circumstances, however, prevented so long a series of measures ; Lord Lindsay's yacht with the instruments did not arrive at the Mauritius until November 2, and it was not till November 10 that the first heliometric observations could be made. The first reliable series was obtained two evenings later, and from this time to November 30, observations were secured on twelve evenings and eleven mornings, some of them not being so complete as was desirable. It will thus be seen that Juno was past opposition before work could be commenced, and this first attempt to determine the solar parallax, through measuring the diurnal parallax of a minor planet with the aid of the heliometer, was consequently made under less favourable conditions than may